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ABSTRACT

A project was conducted to coordinate and make intelligible those competencies and/or indicators that are common to mathematics/science/vocational areas, place them in a form usable by classroom teachers, and disseminate the results. Activities were undertaken to analyze the mathematics/science and vocational education areas to determine where the mathematics/vocational and science/vocational aspects occupy common ground. Following the identification of their similarities, curriculum alignment charts for each selected course in the vocational education curriculum were created. Charts contained three columns: vocational education performance indicator, vocational education competency and mathematics or science skill/concept, and relevant mathematics or science competency indicator. The reverse side contained suggestions for instructing students in the skills listed on the front and activities which might be appropriate. (Appendixes, amounting to approximately one-half of the report, include charts of performance indicators for mathematics and science, process for determining the percentage of mathematics/science contained in vocational competencies and charts showing the percentage of mathematics/science contained in vocational competencies before and after editing, sample vocational competency statements related to science and mathematics, and examples of curriculum alignment charts for vocational education in manufacturing with relevant math competency indicators, relevant science competency indicators, and selected teacher helps in each instance.) (YLB)

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PREFACE

This monograph provides examples of the outcomes generated by Haywood County Schools on a project funded through the Research Coordinating Unit, Division of Vocational Education, North Carolina Department of Public Instruction.

The project has been approached on the premise that the final results would be of benefit to teachers of vocational education and would be useful as a guide for math or science teachers who give vocational students the background they need to succeed in their chosen area.

The overall plan has been formulated in such a way as to assure a thorough analysis of the mathematics/science and vocational education areas in order to determine where the math/vocational and science/vocational occupy common ground. Following the identification of their similarities, in terms of math/science, curriculum alignment charts were created—one for each selected course in the vocational education curriculum. Construction of the chart was done in such a way as to be readable from either left or right depending upon whether a math/science person or a vocational education person were using the chart. The chart contains three columns set up as follows:

Vocational Education Performance Indicator	Vocational Education Competency Math/Science Skill/Concept	Relevant Math/Science Competency Indicator

The reverse side contains suggestions for instructing students in the skills listed on the front and activities which might be appropriate.

There is clearly a need for both vocational and math/science teachers to develop a greater grasp of the inter-relatedness of their respective areas. This mutual understanding should enhance interest, coordinate the program across curriculum areas, and provide mutual support.

The precise purpose of this project is to coordinate and make intelligible those competencies and/or indicators which are common to math/science/vocational areas, place them in a form which is highly useable by classroom teachers, and disseminate the results of this effort to appropriate audiences in other places.

Included in the monograph are examples of supportive materials and other products which have been generated from project activities.

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Activities and procedures funded by the Division of Vocational Education are governed by the philosophy of simple fairness to all. Therefore, the policy of the Division is that all operations will be performed without regard to race, sex, color, national origin, or handicap.

OVERVIEW VOCATIONAL/MATH/SCIENCE PROJECT

In August, 1983, Haywood County received a request for proposals for identifying math and science competencies taught in secondary vocational education. Proposals were submitted in October, and in November, 1983, a memorandum was received to the effect that, pending approval of the State Board, Haywood County's proposals had been selected. In January, 1984, approval was received from the State Board of Education.

Sharon Porter, Secondary Supervisor, and Haywood Willis, Vocational Director, were selected as Project Co-directors. Freda Blanton was employed as part-time Program Analyst. An Advisory Committee was selected to insure that the findings of the project staff would be useful and useable. This committee is headed by Samuel S. Smith, Associate Superintendent of Haywood County Schools. Other members are Charles McConnell, Superintendent of Haywood County Schools, the Co-directors, program analyst, Bill Upton, Principal, Pisgah High School, and Charles Starnes, Principal, Tuscola High School. Dr. James M. Morrow of Western Carolina University was engaged as the project evaluator. Consultants from Western Carolina were selected in the fields of math, science, and vocational education. Dr. James Ralph Devane, math; Dr. Fredrick W. Harrison, science; and Dr. Jerry Lee Cook, vocational education were selected to provide the professional services required to assure that the Curriculum Alignment Charts are correct in terms of the body of knowledge and practice in their respective fields.

The following vocational courses were selected by the State Department and the Vocational Director as the program areas for review:

Trade and Industrial Education

Science	Math
Cosmetology	Machine Shop
Electronics	Carpentry
Automotive Mechanics	Welding
Graphics	Automotive Mech.
Textiles	Masonry
	Textile
	Cabinet/Furniture
	Electricity

Industrial Arts Education

Science and Math

Construction

Energy and Power Technology

Technical Drawing and Planning

Wood Technology

Manufacturing

Science and Math performance indicators relating to skills needed in the selected vocational courses have been keyed into the computer by numerical code and can be called up by skill, grade level, etc. However, the North Carolina Competency Goals and Performance Indicators Guide must be used as a reference to secure the complete competency statements. Plans are to key in the complete statement at a later date. (Appendix A1, Page 8 and Appendix A2, Page 9)

Following is an overview of the major objectives and activities for implementing the project.

Objective 1 - Identify vocational education programs and courses which either teach a substantial amount of math/science or for which students must know a substantial amount of math/science in order to succeed.

Activities - Vocational teachers from Haywood County and Vocational Directors and vocational teachers from surrounding counties were requested to review the selected programs to determine the degree of math and science content in vocational competency statements and test items. Science and math teachers from Haywood County were asked to review the same competencies and make a determination on the math and science they felt the competency statements contained. The project staff then compiled the selected competencies and a percentage chart was designed to compare vocational findings with math and science selections. (Appendix B1, Process, Page 10 - Appendix B2, Chart, Page 11)

After editing, a second percentage chart was constructed to reflect the final math/science content in the vocational areas. (Appendix B3, Page 12)

Objective 2 - Conduct a comparative analysis of Vocational Education programs and courses and identify specific math/science competencies included therein, utilizing math/science competency goals and performance indicators as the criteria.

Activities - Vocational competency statements and vocational test item banks were analyzed by the vocational teachers and specific math and science skills were identified as being contained in the competency. The math and science teachers identified the relevant math/science competency needing to be learned by the student in order to succeed in a given vocational program. (Appendix C1, Science, Page 13 - Appendix C2, Math, Page 14)

Objective 3 - Utilize inter-disciplinary Vocational Education - Math/Science teams to translate relevant math/science goals and performance indicators into terms compatible with those used in vocational education programs/courses.

Activities - During July, 1984, vocational teachers and math/science teachers worked in teams along with the project staff to translate math/science goals/indicators into related vocational skills. These indicators and skills were then written on the curriculum alignment chart in rough draft form and later typed, edited, and retyped. Several of these curriculum alignment charts have been keyed into the computer, and plans are to complete this process so all charts will be accessible on disk. (Appendix D1, Science, Page 15 - Appendix D2, Math, Page 17)

Objective 4 - Utilize inter-disciplinary Vocational Education - Math/Science teams to formally identify vocational education competencies containing stated or implied math/science competencies and complete the design of the interchangeable curriculum alignment charts.

Activities - Vocational teachers, math/science teachers, and project staff selected vocational indicators containing math/science competency skills. Information from vocational test item banks and suggested activities from all teams was developed as a resource for the back of the curriculum alignment chart. These are only suggested resources and are not intended as a complete listing. (Appendix E1, Science, Page 16 - Appendix E2, Math, Page 18)

Objective 5 - Prepare for systematic dissemination and inservice activities aimed at awareness and training of others in the utilization of materials and processes developed under the project.

Activities - Tuscola High School Art Department with Mary Ellen Williams, art teacher, has been involved in designing the cover for the brochure we we are using as part of the dissemination. The carpentry class at Pisgah High School, under the direction of Ross Bennett, built a tri-fold for display purposes. A local printer was contacted for printing when the project materials were ready for reproduction. Several activities have been conducted by staff members in the dissemination process. Vocational/Science /Math teachers are to be, or have been, involved in awareness activities. Plans have been made for regional and state dissemination and training and several local awareness activities have been held.

Objective 6 --Design and implement a formal evaluation plan appropriate to project activities and suitable for measuring the quality and achievement of project objectives.

Activities - An evaluator from Western Carolina University was selected and a contract negotiated for services required by the project. Arrangements were made for consultant services with vocational and math department personnel at the university level. A final comprehensive evaluation report on the total project operation was prepared by the evaluator.

QUESTIONS - ANSWERS - GENERAL CLARIFYING STATEMENTS

1. What does editing do to the percentages of math/science calculations?

   There are two tables of percentages. The original, which was based on responses from vocational/math/science teachers, and another when all editing was completed.

2. Clarify original procedures for listing Competency Goals and Performance Indicators.

   Vocational teachers from Haywood County and vocational directors and vocational teachers from surrounding counties were requested to review the selected programs to determine the degree of math and science content in vocational competency statements and test items. Science and math teachers from Haywood County were asked to review the same competencies and make a determination on the math and science they felt the competency statements contained. Performance Indicators were reviewed and a consensus reached.

3. Basis for Editing Process

   A committee of math, science, and vocational teachers, project directors and project analyst, omitted the originally submitted vocational indicators and statements which were not directly related to math or science skills. When there was a difference of opinion on the acceptability of an indicator as to math or science content, the statement was discussed and a consensus was reached by the committee. Due to the vast number of acceptable indicators, a second and third editing was necessary. The process was the same for these editings. In the interest of space limitations, duplications were omitted.

4. Identify the standard or basis against which to measure the indicators or the critera to include

   Math
   1st level - 8th grade median
   2nd level - General Math selected over 7th grade
   If skill did not appear in general math we looked to 7th grade
   3rd level - Introductory Algebra Part I
   4th level - Introductory Algebra Part II
   5th level - Algebra I
   6th level - Geometry
   7th level - Algebra II

   Science
   1st level - Elementary Science K-12 looked at first for skill indicated in vocational competency
   2nd level - Elementary Science Grades 4-6
   Depended on vocational subject matter as to higher levels of science. This was a judgment.
   Life Science
   Earth Science
   Physical Science
   Biology
   Physics

5. **Is** math simpler to define than science?

Yes! Because of the structure of the math competency statements.

6. **How** was order for math competencies determined?

Math competencies are listed on the Curriculum Alignment Chart in the same **order** they appear in the North Carolina Competency Goals and Performance **Indicators.**

7. **Explanation** of columns on the Alignment Charts - Source

Column 1:	North Carolina Vocational Education Test Item Bank North Carolina Vocational Education Competency Statements
Column 2:	North Carolina Vocational Education Competency Statements
Column 3:	North Carolina Competency Goals and Performance Indicators (Math and Science); Heath Mathematics Program

Selected Teacher Helps on reverse side:

North Carolina Vocational Education Test Item Bank
Curriculum and Instructional Materials from Oklahoma Trade and Industrial Education Programs
General Woodmaking; by Chris H. Groneman
Practical Problems in Mathematics for Carpenters; by Harry Huth

PROCESS FOR DEVELOPING THE VOCATIONAL/MATH/SCIENCE CURRICULUM ALIGNMENT CHART

- SELECTED CO-DIRECTORS
- SELECTED PROGRAM ANALYST
- SELECTED ADVISORY COMMITTEE
- SELECTED VOCATIONAL COURSES FOR REVIEW (SELECTED BY STATE DEPARTMENT AND VOCATIONAL DIRECTOR)
- SELECTED EVALUATOR FROM WESTERN CAROLINA UNIVERSITY
- SELECTED CONSULTANTS FROM WESTERN CAROLINA UNIVERSITY IN FIELDS OF MATH, SCIENCE, AND VOCATIONAL EDUCATION
- CONTACTED VOCATIONAL TEACHERS AND REQUESTED THEY MARK BOTH MATH AND SCIENCE RELATED VOCATIONAL COMPETENCY STATEMENTS
- DESIGNED CURRICULUM ALIGNMENT CHART
- CONTACTED SCIENCE AND MATH TEACHERS AND REQUESTED THEY MARK VOCATIONAL COMPETENCY STATEMENTS RELATED TO THEIR FIELD. THEY WERE GIVEN VOCATIONAL INDICATORS AND TEST ITEMS FOR REFERENCE.
- REQUESTED SCIENCE AND MATH TEACHERS TO THEN COMPARE THEIR RESPONSES TO VOCATIONAL RESPONSES.
- PROJECT STAFF COMPILED AND EDITED COMPETENCY STATEMENTS SELECTED BY MATH/VOCATIONAL AND SCIENCE/VOCATIONAL TEACHERS.
- PROJECT STAFF AND MATH/SCIENCE TEAM MATCHED MATH OR SCIENCE COMPETENCY WITH VOCATIONAL INDICATOR
- SELECTION OF RESOURCES TO BE USED FOR EACH STATEMENT WAS MADE BY PROJECT STAFF AND THE VOCATIONAL/MATH/SCIENCE TEAM
- MATH AND SCIENCE COMPETENCIES FROM NORTH CAROLINA COMPETENCY GOALS AND PERFORMANCE INDICATORS KEYED TO DISK FOR MICRO-COMPUTER PRINTOUTS.
- PERCENTAGE COMPARISON OF RESPONSES TO VOCATIONAL COMPETENCY STATEMENTS FOR VOCATIONAL EDUCATION MATH AND SCIENCE.
- KEYING INTO THE COMPUTER THE RESULTS OF THE PROJECT EFFORT.
- DISSEMINATION

SKILL	SETTING	COURSE	NO.	PAGE
6.03 SOLVE	EQUATIONS	ALG 1		
SIMPLIFY	% TO PROPER FRACTION	GRADE 7	5.05	131
DIVIDE	3-DIG BY TENS	GRADE 7	2.12	130
ESTIMATE QUOTIENT	4-DIG BY 2-DIG	GRADE 7	2.10	130
DIVIDE	4-DIG BY 2-DIG	GRADE 7	2.11	130
IDENTIFY	ABSOLUTE VALUE	GRADE 8	7.03	134
FIND	ABSOLUTE VALUE	ALG 1	5.02	142
SOLVE	ABSOLUTE VALUE	ALG 1	6.11	143
SOLVE EAUATIONS	ADD, SUB.	INTRO ALG (2)	7.06	137
SOLVE LINEAR EQ	ADD/MULT PROP EQUAL	GRADE 8	10.04	134
SOLVE LINEAR EQ	ADD/MULT PROP EQUAL	GRADE 8	10.05	134
SOLVE LINEAR EQ	ADDITION PROP	INTRO ALG (2)	5.02	137
SOLVE LINEAR INEQ.	ADDITION PROP	INTRO ALG (2)	6.01	137
SOLVE LINEAR EQ	ADDITION PROP	GEN MATH	11.01	140
SOLVE LINEAR EQ	ADDITION PROP EQUAL	GRADE 8	10.02	134
SOLVE EQUATIONS	ADDITION PROP.	INTRO ALG (1)	8.02	135
SOLVE PROBLEMS	AGE, COIN	ALG 1	6.07	143
SIMPLIFY	ALGEBRAIC EXPRESSION	INTRO ALG (1)	9.04	136
SIMPLIFY	ALGEBRAIC EXPRESSION	INTRO ALG (1)	9.05	136
BISECT	ANGLE	GEOMETRY	1.11	144
CONSTRUCT	ANGLE BISECTOR	GEOMETRY	14.03	146
NAME	ANGLES	GRADE 7	6.03	132
NAME	ANGLES	INTRO ALG (1)	10.01	136
MEASUREMENT	ANGLES	INTRO ALG (1)	10.05	136
IDENTIFY	ANGLES	GEN MATH	10.04	139
MEASURE	ANGLES	GEOMETRY	1.08	144
CLASSIFY	ANGLES	GEOMETRY	4.02	144
CONSTRUCT	ANGLES	GEOMETRY	14.02	146
DETERMINE	ANGLES CONGRUENT	GEOMETRY	1.09	144
SOLVE PROBLEMS	ANGLES OF TRIANGLES	ALG 1	13.03	144
FIND MEASURES	ANGLES, TRIG. FUNCT	ALG 1	13.09	144
IDENTIFY	ANGLES:ADJACENT,VERT	GEOMETRY	4.04	144
MEASURE	ANGLES:EXTERIOR	GEOMETRY	7.08	145
CONSTRUCT	ARC:MIDPOINT	GEOMETRY	14.08	146
FIND	AREA	GRADE 8	6.07	134
SOLVE PROBLEMS	AREA	INTRO ALG (1)	10.08	136
FIND	AREA	GEN MATH	5.04	139
SOLVE PROBLEMS	AREA	ALG 1	13.04	144
FIND	AREA OF CIRCLE	GRADE 8	6.08	134
FIND	AREA PRISM, CIR CYL	GRADE 8	6.11	134
FIND	AREAS, RECTANGLES	GRADE 7	7.10	132
IDENTIFY	ASSOC. PROP. OF ADD	GRADE 8	1.12	132
IDENTIFY	ASSOC. PROP. OF MULT	GRADE 8	1.14	133
SQUARE	BINOMIAL	INTRO ALG (1)	9.09	136
RAISE TO POWER	BINOMIAL	INTRO ALG (2)	8.07	137
FACTOR	BINOMIAL	INTRO ALG (2)	8.17	137
MULTIPLY	BINOMIALS	INTRO ALG (1)	9.07	136
FIND PRODUCT	BINOMIALS	INTRO ALG (2)	8.15	137
MEASUREMENT	CAPACITY	GRADE 7	7.03	132
SOLVE PROBLEMS	CAPACITY	GRADE 7	7.07	132
MEASUREMENT	CAPACITY	GRADE 8	6.03	133

PERFORMANCE INDICATORS
******* SCIENCE ******

BY COURSE

SKILL	SETTING	COURSE	SUBHEAD	NO.	PAGE
CONSTRUCT	FOOD CHAIN	BIOLOGY	MICROBIO.	2.02	221
LIST	LIVING THINGS	BIOLOGY	NATURE	2.01	220
LIST	CELLS/STRUCTURE	BIOLOGY	NATURE	4.02	221
LIST	FUNGI	BIOLOGY	MICRO	3.01	221
LIST	PLANTS	BIOLOGY	MICRO	3.01	221
LIST	ALGAE	BIOLOGY	MICRO	4.02	221
LIST	CONDUCTION	BIOLOGY	MULTICELL	3.01	221
LIST	WATER	BIOLOGY	MULTICELL	3.01	221
LIST	PLANTS	BIOLOGY	MULTICELL	3.01	221
LIST	REPRODUCTION/PLANTS	BIOLOGY	MULTICELL	4.01	221
LIST	SPONGES	BIOLOGY	MULTICELL	1.02	222
LIST	IMPORTANCE	BIOLOGY	MULTICELL	1.02	222
LIST	COELENTERATES	BIOLOGY	INVERT	2.02	222
LIST	BILATERAL SYM.	BIOLOGY	INVERT	3.01	222
LIST	ORGANISMS	BIOLOGY	INVERT	3.01	222
LIST	WORMS	BIOLOGY	INVERT	3.02	222
LIST	MOLLUSKS	BIOLOGY	INVERT	4.02	222
LIST	SEGMENTATION	BIOLOGY	INVERT	5.02	222
LIST	ANNELIDS	BIOLOGY	INVERT	5.03	222
LIST	WORMS	BIOLOGY	INVERT	5.03	222
LIST	ARTHROPODS	BIOLOGY	INVERT	6.02	222
LIST	RADIAL SYMMETRY	BIOLOGY	INVERT	7.01	222
LIST	ECHINODERMS	BIOLOGY	INVERT	7.02	222
LIST	STARFISH	BIOLOGY	INVERT	7.02	222
LIST	AMPHIBIOUS	BIOLOGY	VERT	4.02	222
LIST	BIRDS	BIOLOGY	VERT	6.03	222
LIST	FLYING	BIOLOGY	VERT	6.03	222
LIST	VERTEBRATES	BIOLOGY	VERT	8.01	223
LIST	HUMAN BODY	BIOLOGY	HUMANS	3.01	223
LIST	ORGANS	BIOLOGY	HUMANS	3.01	223
LIST	DRUGS	BIOLOGY	HUMANS	4.02	223
LIST	ALCOHOL	BIOLOGY	HUMANS	4.02	223
LIST	NARCOTICS	BIOLOGY	HUMANS	4.02	223
LIST	TOBACCO	BIOLOGY	HUMANS	4.02	223
EXPLAIN	TIME	BIOLOGY	BACKGROUND	2.01	220
EXPLAIN	EXPERIENCE	BIOLOGY	BACKGROUND	2.01	220
EXPLAIN	SOCITY	BIOLOGY	BACKGROUND	2.01	220
EXPLAIN	PROBLEMS	BIOLOGY	BACKGROUND	2.01	220
EXPLAIN	HISTORY	BIOLOGY	BACKGROUND	2.01	220
EXPLAIN	PROBLEMS	BIOLOGY	BACKGROUND	2.02	220
EXPLAIN	PEOPLE	BIOLOGY	BACKGROUND	2.02	220
EXPLAIN	HISTORY	BIOLOGY	BACKGROUND	2.02	220
EXPLAIN	CELL PROCESSES	BIOLOGY	BACKGROUND	3.01	221
EXPLAIN	CELL RESPIRATION	BIOLOGY	BACKGROUND	3.01	221
EXPLAIN	PHOTO SYN THESIS	BIOLOGY	BACKGROUND	3.01	221
EXPLAIN	CELLS	BIOLOGY	BACKGROUND	4.03	221
EXPLAIN	POPULATION	BIOLOGY	CONTINUITY	3.01	221
EXPLAIN	VARIATION	BIOLOGY	CONTINUITY	3.01	221
EXPLAIN	VIRUSES	BIOLOGY	MICRO.	1.04	221
EXPLAIN	BACTERIA	BIOLOGY	MICRO.	1.04	221
EXPLAIN	RESEARCH	BIOLOGY	MICRO.	1.04	221

PROCESS FOR DETERMINING PERCENT OF MATH/SCIENCE CONTAINED IN VOCATIONAL COMPETENCIES

The total number of competency statements to be used was determined by responses from all vocational teachers in a particular area and responses returned from math and science teachers.

Example: Automotive Mechanics has 60 competency statements; three (3) vocational teachers from Automotive Mechanics participated; one hundred eighty (180) (3 x 60) total statements to be used. All indications by vocational teachers as to competencies containing math/science were added. A total of seventy-eight (78) math statements and one hundred eighteen (118) science statements were then divided by total competencies (180) to arrive at a percentage of math and science vocational people felt was included in competencies. This same procedure was followed for obtaining the percentage the math and science teachers felt was contained in the vocational statements. (Appendix B2, Page 11)

After the editing process was completed, the remaining vocational competency statements for each area were totaled and divided by the total number of competency statements to arrive at the percentages listed. (Appendix B3, Page 12)

PERCENTAGE MATH/SCIENCE CONTAINED IN VOCATIONAL COMPETENCIES
9-14-84

SUBJECT	VOCATIONAL RESPONSE % MATH	% SCIENCE	CONTENT AREA RESPONSE % MATH	%SCIENCE
Cosmetology		74.358		75.
Electronics		34.09		86.36
Automotive Mechanics	43.33	65.555	48.33	85.83
Graphics		33.33		33.33
Textiles	79.487	58.97	66.666	15.38
Machine Shop	61.538		44.615	
Carpentry	48.33		45.	
Welding	45.83		41.666	
Electricity	37.14		40.	
Masonry	75.757		61.36	
Cabinet/Furniture	31.578		24.137 Furniture 23.68 Cabinet	
Construction	12.5	8.33	30.555	16.666
Energy and Power	21.036	63.109	24.39	81.25
Tech. Draw. & Plan.	37.43	3.076	25.38	84.328
Wood Technology	25.287	27.01	27.01	43.678
Manufacturing	23.23	17.485	43.939	57.83

PERCENTAGE MATH/SCIENCE CONTAINED IN VOCATIONAL COMPETENCIES AFTER EDITING

1-29-85

SUBJECT	MATH	SCIENCE
Cosmetology		73.076
Electronics		86.36
Automotive Mechanics	33.33	71.66
Graphics		31.25
Textiles	48.717	41 .025
Machine Shop	85.71	
Carpentry	53.33	
Welding	58.33	
Electricity	22.857	
Masonry	54.545	
Cabinet/Furniture	26.315	
Construction	36.11	25.00
Energy and Power	25.00	44.318
Technical Drawing and Planning	50.746	20.895
Wood Technology	36.78	21.839
Manufacturing	17.17	6.06

See clarifying statement No. 3, page 5, for explanation for editing process.

Vocational Education X INDICATES ONE OR MORE RESPONSES TO COMPETENCY STATEMENT AS BEING RELATED TO SCIENCE.

APPENDIX C 1

INDUSTRIAL ARTS EDUCATION

SC.	VOC	COMPETENCY STATEMENTS	Core (x)	If Course Length: 4 1/2 Weeks	9 Weeks	18 Weeks	Performance Indicators
	X	02. Recognize the impact of the manufacturing industry on communities and countries.		S	S	C	Performance indicators for this course sequence are in the form of sample test items. Refer to Competency/ Test-Item Bank number VEC-IA-C/TIB-8100.
		Designing the Product					
X		022. Describe how consumer demand effects manufacturing.	X	C	C	C	
	X	023. Identify ways in which a manufacturer determines the demand for a product.	X				
X		01. Demonstrate process of consumer research.		S	S	C	
X	X	024. Describe the process of research and development.	X	C	C	C	
X	X	025. Demonstrate the steps of product design.	X	C	C	C	
		01. Demonstrate development of alternative solutions in the construction of models (refining solutions, selecting final designs, selecting material, making working drawings, build prototype).		S	S	C	
X	X	026. Describe the function of technical manuals.	X	C	C	C	
		Planning for Production of the Product					C-Core Competency S-Supplemental Competency
		027. Describe steps in production planning.	X				
		01. Determine processes and operation.		S	C	C	
	X	02. Develop flow pattern.		S	S	C	
X	X	028. Describe function of automation in manufacturing.	X	C	C	C	
	X	029. Describe ways in which work is measured and ways in which workers are paid.	X				
X	X	01. Demonstrate the process of time and motion study.		S	S	S	
		02. List different types of pay systems.		C	C	C	
		030. List the elements of product cost estimate.	X				
		01. List materials cost, labor, overhead, and profit figures.		C	C	C	
		02. Define "break even point" as it relates to product manufacturing.		C	C	C	
		031. Define and identify steps in the tooling-up process.	X				
X	X	01. Demonstrate the process of machine and tool selection.		S	C	C	
X	X	02. Identify the need for jigs and fixtures.		S	C	C	
X		03. Demonstrate the process of designing and building jigs and fixtures.		S	S	S	
	X	032. Describe how the production process is controlled.	X				
		01. Identify the elements of:					
		a. Flow control		S	C	C	
		b. Quality control		C	C	C	
		c. Inventory control		S	S	C	
		d. Production personnel management		S	C	C	
		033. Identify the elements in the design and production of the product package.	X				
X		01. List the functions of a package.		S	S	S	

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X INDICATES ONE OR MORE RESPONSES TO COMPETENCY STATEMENT AS BEING RELATED TO MATH

Vocational Education

APPENDIX C2

INDUSTRIAL ARTS EDUCATION

MATH	VOC.	COMPETENCY STATEMENTS	Core (X)	If Course Length: 4 1/2 Weeks	9 Weeks	18 Weeks	Performance Indicators
X	X	043. Describe the factors necessary to best match the raw materials to the production process.	X				Performance indicators for this course sequence are in the form of sample test items. Refer to Competency/ Test-Item Bank number VEC-IA-C/TIB-8100.
	X	01. Describe how stock sizes of materials affect the design of the product.		S	S	C	
X	X	02. Describe how stock sizes of materials affect the production process.		S	S	C	
		044. Identify the elements of the production processes.	X				
X	X	01. List the processes used in combining and separating materials.		C	C	C	
X	X	02. List the processes used in shaping materials.		C	C	C	
X	X	03. List the processes used in assembling and finishing the product.		C	C	C	
		045. Distinguish visually between hardwoods and softwoods.	X			C	
		046. Identify common hardwoods and common softwoods.	X			C	
		047. Describe how wood is processed from raw stage to a usable product.	X			C	
X	X	048. Describe how wood is sized and sold to the consumer.	X			C	
X	X	049. Use layout tools in woodworking properly.	X			C	
	X	050. Use hand saws safely and properly.	X			C	
X	X	051. Cut by hand a dado, rabbet.	X			C	
X	X	052. Use a miter box safely and accurately.	X			C	
X	X	053. Use the coping saw safely and properly.	X			C	
X	X	054. Describe uses of the wood plane and wood chisel.	X			C	
X	X	055. Use the wood plane and wood chisel safely and properly.	X			C	
X	X	056. Describe the types and uses of hand drills.	X			C	
X	X	057. Use hand drills safely and properly.	X			C	
X	X	058. Describe the types and uses of wood fasteners.	X			C	
X	X	059. Fasten wood together with the hammer and screwdriver safely and properly.	X			C	
		060. Describe the types and uses of common adhesives used in woodworking.	X			C	
		061. Glue wood together using the proper procedures.	X			C	
X	X	062. Select and properly use abrasives (sandpaper) in finishing wood.	X			C	
		063. Describe common finishes that may be applied to wood.	X			C	
		064. Properly apply finishes to wood.	X			C	
X	X	065. Describe the function and operation of the following power tools: jigsaw, band saw, drill press, circular saw, and jointer.	X			C	
X		066. Operate the following power tools in woodworking safely and properly: jigsaw, band saw, drill press, circular saw, and jointer.	X			C	
X	X	067. Use layout tools in metals properly.	X			C	

C-Core Competency

S-Supplemental Competency

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CURRICULUM ALIGNMENT CHART

VOCATIONAL EDUCATION COURSE Manufacturing

APPENDIX D1

VOCATIONAL EDUCATION PERFORMANCE INDICATOR	VOCATIONAL EDUCATIONAL COMPETENCY SCIENCE SKILL/CONCEPT	RELEVANT SCIENCE COMPETENCY INDICATORS
INDICATORS		
024 01. Define research. 02. Define development 03. Explain where new ideas originate.	024 Describe the process of research and development. SKILLS: Discuss issues Interpret observation Demonstrate critical thinking Infer investigations State conclusions Use proper controls	PHYSICAL SCIENCE/ATTITUDES Grades 7-12 1.02 Display an open and analytical mind in examining and discussing issues which invite a variety of opinions 5.01 Make interpretations of observations and data obtained from experiments 5.02 Demonstrate critical thinking and the use of scientific inquiry when given a scientific problem PHYSICAL SCIENCE/PROCESS SKILLS Grades 7-9 8.01 Infer what the results of an investigation mean 9.01 State logical conclusions when given a collection of data 10.01 Identify variables and use proper controls when given appropriate materials and an experiment

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VOCATIONAL EDUCATION COURSE Manufacturing - Science

C24 Describe the process of industrial research and development by defining these terms.

1. Research
2. Development

Explain the process of (1) Research and (2) development and give three reasons for research.

What is industrial research and how does it differ from development? Where do new ideas come from?

Definition of Research: "the process of retrieving, describing, and experimenting in order to discover new knowledge."

Reasons for Research:
1. To satisfy man's wish to udnerstand his physical surroundings.
2. To add to the knowledge needed to solve problems important to man's health and safety.
3. To invent processes or products to satisfy man's wants and needs.

Definition of Development: "the work of designing and engineering new or improved processes or products by using research findings and other knowledge."

New ideas come from: people trying to make man's life easier, more pleasant; trying to make work easier, faster. New ideas also come from research and development.

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CURRICULUM ALIGNMENT CHART

VOCATIONAL EDUCATION COURSE Manufacturing

APPENDIX D2

VOCATIONAL EDUCATION PERFORMANCE INDICATOR	VOCATIONAL EDUCATIONAL COMPETENCY MATH SKILL/CONCEPT	RELEVANT MATH COMPETENCY INDICATORS
INDICATORS		
049 01. Check stock for squareness (one corner only) 02. Layout desired length 03. Layout desired width 04. Layout chamfered edge 05. Layout angle 06. Layout circle or radius	049 Demonstrate proper use of wood-working layout tools	GENERAL MATH 10.08 Identify parts of a circle (arc, radius, center, diameter, chord) GEOMETRY 1.08 Use a protractor to find the measure of an angle. HEATH G3 4.01 Identify centimeter and inch as small units for measuring length HEATH G5 4.02 Identify right angles, angles greater than and angles less than a right angle 4.03 Identify a degree as a unit for measuring angles. HEATH G7 7.02 Determine length, width, or heigth by measuring an object or drawing to the nearest centimeter, meter, or appropriate customary unit (including fractions)

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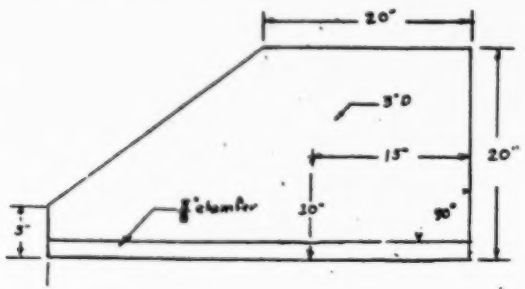
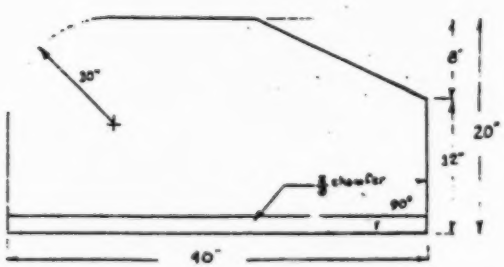
APPENDIX E 2

VOCATIONAL EDUCATION COURSE Manufacturing - Math
049

Study the illustration below before beginning any layout work. Using the stock supplied by the teacher, perform the following layout operations:

1. Check Stock for flatness.
2. Check stock for squareness (one corner only)
3. Layout desired length
4. Layout width as shown in illustration
5. Layout chamfered edge (if 3/4" wood is used).
6. Layout angle
7. Layout circle or radius (depending on illustration).

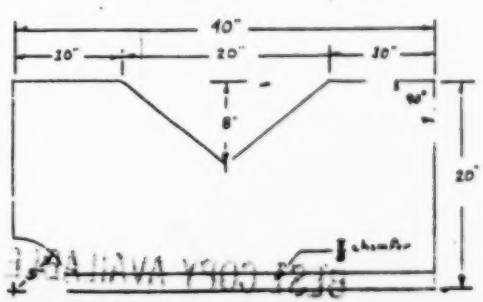




WOODWORKING LAYOUT TOOLS CHECK LIST.

THE STUDENT:

1. Checks stock for flatness
   Sets blade of steel rule or framing square on edge of face of stock
   Holds up to light to note uneveness
2. Checks stock for squareness (One corner only)
   Uses framing square
   Makes certain blade of square is held tightly against edge of stock.
3. Lays out length according to illustration
   Uses zig-zag rule (on edge) or push-pull tape.
4. Lays out width according to illustration
   Uses steel rule set on edge.
5. Lays out chamfer edge (if 3/4" wood is used)
   Uses marking gage
   Sets gage carefully; checks accuracy on scrap stock
   Pushes gage away from self with marking pin at angle pointing toward operator
6. Lays out angle
   Uses T-bevel. Sets blade for desired angle.
   Checks on scrap stock for accuracy.
7. Lays out circle or radius
   Uses dividers. Sets diameter, checks on scrap stock for accuracy
   Holds one end on center and scribes radius or circle.



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